22 September 1969

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

LIE DETECTORS, RECORDING

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the technical performance, engineering adequacy and technical characteristics of recording lie detectors relative to criteria contained in Quality Materiel Requirements (QMR), Small Development Requirements (SDR), or other applicable documents, and determining their suitability for an intended use.

2. BACKGROUND

Recording lie detectors are used to simultaneously measure and record various bodily functions of a subject's inner autonomic reaction to pertinent questions. To determine the presence or absence of deception by a subject when answering a series of questions, three independent physical characteristics are measured simultaneously and recorded on a moving paper chart; pulse rate and relative blood pressure (cardio section), skin resistance or rate of perspiration (galvo section), and respiration or breathing rate and depth (pneumo section). Each chart tracing is made by a recording pen moving in accordance with the detector which is placed on the subject.

3. REQUIRED EQUIPMENT

a. Resistance decade.
b. Variable speed motor.
c. Tachometer.
d. Measuring equipment (yardstick, rule).
e. Cylindrical compressor (automotive ring compressor).
f. Tools and test equipment as required for evaluation or maintenance of the test item.

4. REFERENCES

A. MIL-STD-810B, Environmental Test Methods
B. MIL-STD-454B, General Requirements for Electronic Equipment
C. TM 11-5535, Lie Detecting Set AN/USS-2
D. TM 11-5530, Lie Detecting Set AN/USS-2A
E. TM 11-5538, Lie Detecting Set AN/USS-2B
F. TM 11-5538A, Recording Lie Detector AN/USS-2C
G. TM 11-6695-203-15, Organizational DSGS and Depot Maintenance Manual: Lie Detector, Recording AN/USS-2E
H. MTP 6-2-015, Amplifiers, General
I. MTP 6-2-215, Public Address Set
J. MTP 6-2-245, Recording and Reproducing Equipment Tape
K. MTP 3-1-002, Confidence Intervals and Sample Size

5. SCOPE

5.1 SUMMARY

5.1.1 Technical Characteristics

The procedures outlined in this MTP provide general guidance for determining the degree to which the item under test meets the military requirements for Recording Lie Detectors as expressed in appropriate QMR, SDR, or other applicable documents. The cumulative test results, together with the results of appropriate common engineering tests will allow an estimate to be made of the degree to which the design requirements for Recording Lie Detectors have been met, and the suitability of the item under test to meet the operational need.

The specific tests to be performed and their intended objectives are listed below:

a. Preoperational Inspection - The objective of this subtest is to determine if the test and support equipment is complete, electrically and mechanically correct, and meets the specified physical requirements.

b. Performance - The objective of this subtest is to determine the performance characteristics of the test item (i.e., air leakage rate, adequacy of centering control, sensitivity of the cardio-sphygmograph; resistance range, sensitivity, self-center function response time of the galvanometer tests; air leakage rate, adequacy of centering control, frequency response of the pneumograph tests).

5.1.2 Common Engineering Tests

Not included in this MTP are the following Common Engineering Tests which apply to these commodities:

a. 6-2-502, Human Factor Engineering
b. 6-2-503, Reliability
c. 6-2-504, Design for Maintainability

5.2 LIMITATIONS

These procedures are applicable to tactical military equipment only, and are not intended to cover commercial equipment or military adaptions of commercial equipment.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select test equipment ideally having an accuracy of ten orders of magnitude greater than that of the item under test, and that is in keeping with the state of the art, and with calibrations traceable to the National Bureau of Standards.

b. Record the following information:

1) Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.
2) Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the test items under test, such as stipulated in QMR's, SDR's and TC's.

d. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test.

e. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation of the test item.

f. Prepare a test item sample plan sufficient to ensure that enough samples of all measurements are taken to provide statistical confidence of final data in accordance with MTP 3-1-002. Provisions shall be made for modification during test progress as indicated by monitored test results.

g. Ensure that all test personnel have reviewed all instructional material issued with the test item by the manufacturer, contractor, or government, and performed such preliminary tests as necessary to assure that the test item is in satisfactory condition.

NOTE: Whatever the actual calibration or test procedure to be followed, preliminary preparation of the test item should always include:

1) Visual inspection for obvious physical defects.
2) Preliminary maintenance pointed out by the previous steps.
3) Zero setting of all indicators.
4) Determination of "intended use" position of the various instruments.
5) Sufficient warm-up time for all electronic devices.

6.2 TEST CONDUCT

6.2.1 Preoperational Inspection

a. Upon receipt of the test item at the testing agency, thoroughly inspect the item for obvious physical and electrical defects such as cracked or broken parts, loose connections, bare or broken wires, loose assemblies, bent fragile parts, and corroded plugs and jacks. All defects shall be corrected before proceeding with the test.

b. Perform basic operational and maintenance checks in accordance with pertinent instruction manual(s) and correct any operational discrepancies before starting operational measurement tests.

c. Adjust the equipment as specified in the pertinent operating instructions to ensure that it represents an average equipment in normal operating condition.

6.2.2 Performance

6.2.2.1 Pneumograph Test - Air Leakage Rate

a. Arrange the test set-up as shown in Figure 1.

b Close the pneumo vent (pneumo sensitivity control) and adjust the pneumograph control (pen trace) so that the pneumo pen traces a straight line on the pneumo index line on the chart. The chest tube shall be in its quiescent, normal-length state.

c. Extend the chest tube approximately one-fourth inch and maintain it in that position for one minute.

d. Record pen movement during the above procedure, and during release of the chest tube.

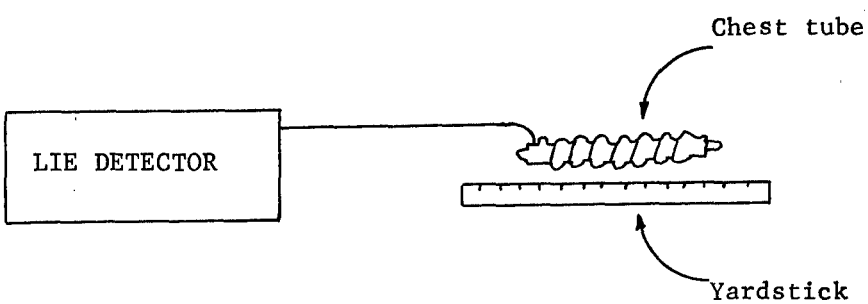

Figure 1. Air Leakage Rate Test Setup

6.2.2.2 Pneumograph Test - Dynamic Range

a. Utilize the test set-up as shown in Figure 1.

b. Adjust the pneumograph sensitivity control to minimum (closed line).

c. Determine the pen displacement as a function of chest tube expansion where the chest tube length is increased in approximately one-eighth inch increments.

d. Repeat for a sufficient number of control settings to adequately determine pneumograph system sensitivity and linearity as a function of control setting.

e. Concurrently with step d. above, vary the input voltage level to the lower and upper acceptable limits and note any changes in stability and drift of the polograph.

6.2.2.3 Pneumograph Test - Response

a. Arrange the test set-up as shown in Figure 2.

b. Set all test item controls and length of fly wheel radius (chest tube expansion) to achieve a trace of useable amplitude (as specified by the appropriate operations procedure).

c. Increase the motor speed from 0 rpm in incremental steps until the trace becomes limited to 75% of the initial amplitude.

d. Repeat with the pneumograph sensitivity control set at its upper and lower limits.

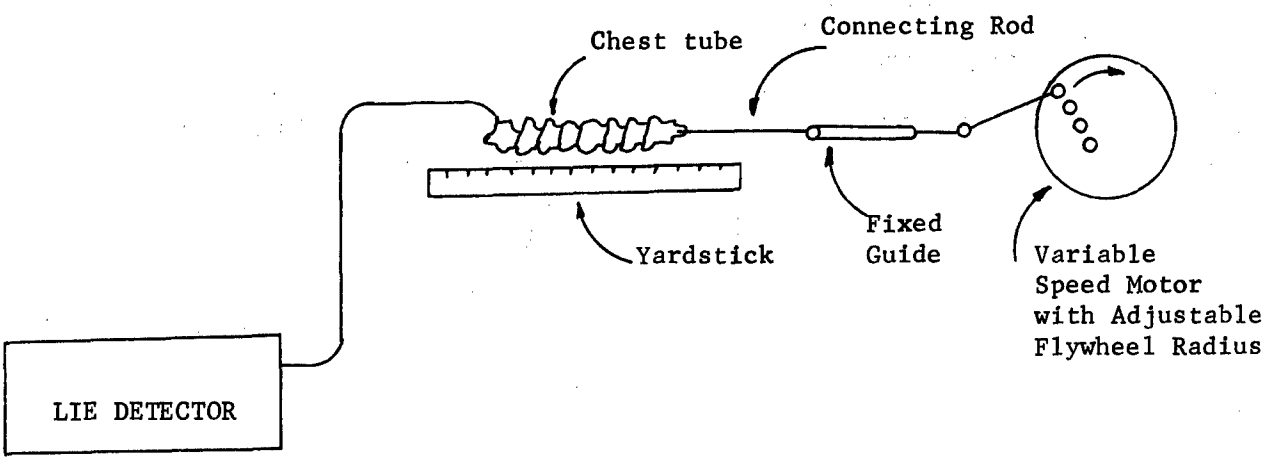

Figure 2. Frequency Response Test Setup

6.2.2.4 Cardio-Sphygmograph Test - Air Leakage Rate

a. Arrange the test set-up as shown in Figure 3.

b. Wrap the arm or wrist cuff around the cylindrical object and secure it in place. Smooth any folds out of the cuff so that it is wrapped flat. Squeeze the hand pump bulb several times. If air pockets form in the cuff, work folds out of cuff.

c. Squeeze the hand pump bulb until the sphyg gage indicates 90-mm Hg; close the hose clamp.

d. Adjust the cardio-sphygmograph control until the cardio pen rides on the cardio index line.

e. Allow the cardio pen to continue tracing on the chart for 15 minutes. Open the cardio vent and continue recording as the pressure is released.

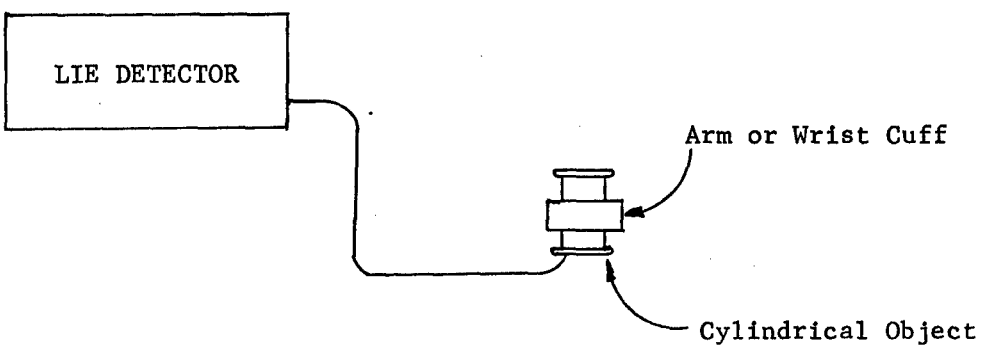

Figure 3. Air Leakage Rate Test Setup

6.2.2.5 Cardio-Sphygmograph Test - Adequacy of Centering Control

a. Repeat steps 6.2.2.4 b. and 6.2.2.4 c. above.
b. Rotate the cardio-sphygmograph control throughout its range and note the limits of the cardio pen travel.

6.2.2.6 Cardio-Sphygmograph Test - Sensitivity

a. Repeat steps 6.2.2.4 b. and 6.2.2.4 c. again.
b. Adjust the cardio-sphygmograph control until the cardio pen rides on the cardio index line.
c. Compress the cuff gently with a cylindrical compressor until the sphyg gage indicates 92 (a 2-mm pressure increase). Record the cardio pen excursion.
d. Release the cylindrical compressor and again record pen response,
e. The test shall be repeated as necessary to evaluate the effects

of such resonance on sensitivity controls that the specific test item may possess.

6.2.2.7 Galvanometer Test - Resistance Range

a. Arrange test set-up as shown in Figure 4.

b. Set the resistance decade to the lowest value which may be balanced by the galvo section bridge circuit. Note decade resistance value and test item indicated value. Test item controls (where existent) shall be adjusted as follows:

1) Self center switch - set to self center.
2) Sensitivity control (ohms/in) - set to minimum.

c. Increase the resistance decade in incremental steps up to the maximum value which may be balanced by the galvo section bridge circuit and record bridge circuit indicated values as a function of decade resistance value.

NOTE: Human skin resistance varies over the range of approximately 2,500 - 140,000 ohms.

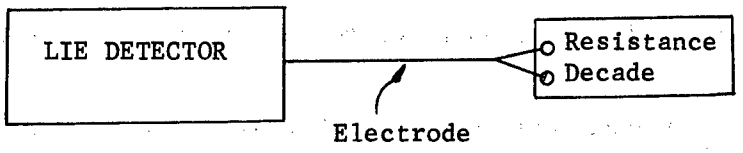

Figure 4. Test Setup for Galvanometer Tests

6.2.2.8 Galvanometer Test - Sensitivity

a. With the test set-up as shown in Figure 4, set the resistance decade to 50,000 ohms and balance bridge circuit in accordance with the appropriate operations procedures. The test item sensitivity (reactivity or ohms/inch) control shall initially be adjusted for minimum pen deflection.

b. Where existent, check to see that the self centering function is set for normal operation.

c. Set the decade resistance for 51,000 ohms and note the pen deflection. Return the resistance decade to 50,000 ohms.

d. Set the decade resistance to 49,000 ohms and note the pen deflection. Return the resistance decade to 50,000 ohms.

e. Repeat the above steps for additional 1000 ohm increments and decrements out to the resistance limits (2,500 - 140,000 ohms).

6.2.2.9 Galvanometer Test - Self-Center Function Response Time

a. Repeat a portion of the sensitivity test above with the self centering function set for automatic self centering operation.

NOTE: The primary interest of this test is the time required for the galvo pen to return to the galvo index line following resistance decade change.

b. Annotate the chart record to indicate the time interval from the pen excursion to its return to the galvo index line.

6.2.2.10 Audio Section Tests

a. Test the performance characteristics of the audio components in accordance with applicable sections of the following MTP's.

1) MTP 6-2-170, Loudspeakers
2) MTP 6-2-015, Amplifiers, General
3) MTP 6-2-195, Microphones
4) MTP 6-2-245, Recording and Reproducing Equipment, Tape

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

6.3.2 Test Conduct

In addition to the specific data requirements delineated in subsequent paragraphs, the following items shall be preserved as a part of the test records:

a. An engineering logbook containing in chronological order, pertinent remarks and observations which will augment test data and support engineering evaluation and analysis of the technical performance of the test item.

b. Supporting photographs, calibration records, and recordings of test anomalies or deviations from the test plan made where necessary.

6.3.3 Preoperational Inspection

Record any damage, broken or missing parts, loose assemblies etc. Report the extent of repairs and adjustment necessary to place equipment in normal operating condition.

6.3.4 Performance

6.3.4.1 Pneumograph Test - Air Leakage Rate

Preserve pneumograph chart tracing suitably marked to indicate chest tube condition at pertinent points and elapsed time.

Preserve pneumograph chart tracing suitably marked to indicate control position and chest tube condition at pertinent points.

6.3.4.2 Pneumograph Test - Dynamic Range

Preserve pneumograph chart tracing suitably marked to indicate sensitivity control setting and chest tube displacement at pertinent points.

6.3.4.3 Pneumograph Test - Frequency Response

Preserve pneumograph chart tracing suitably marked to indicate motor speed (rpm) at pertinent points.

6.3.4.4 Cardio-Sphygmograph Test - Air Leakage Rate

Preserve cardio-sphygmograph tracing suitably marked to indicate elapsed time and sphyg gage pressure at pertinent points.

6.3.4.5 Cardio-Sphygmograph Test - Adequacy of Centering Control

Preserve cardio-sphygmograph tracing suitably marked to indicate centering control position at pertinent points.

6.3.4.6 Cardio-Sphygmograph Test - Sensitivity

Preserve cardio-sphygmograph tracing suitably marked to indicate sphyg gage pressure at pertinent points.

6.3.4.7 Galvanometer Test - Resistance Range

Preserve bridge circuit indicated values as a function of decade resistance value.

Preserve bridge circuit behavior/failure to respond at maximum and minimum resistance points.

6.3.4.8 Galvanometer Test - Sensitivity

Preserve galvanometer tracing suitably marked to indicate resistance values and control settings.

6.3.4.9 Galvanometer Test - Self-center Function Response Time

Preserve galvanometer tracing suitably marked to indicate resistance value, control settings and elapsed time.

6.3.4.10 Audio Section Tests

Audio section tests parameters shall be preserved for analysis in accordance with the applicable portion of the commodity engineering test procedure under which the test was performed.

6.4 DATA REDUCTION AND PRESENTATION

Processing of raw test data, in general, includes but is not limited to the following steps:

a. Marking test data for identification and correlation.
b. Organizing data into tabular and graphical form.
c. Modifying data to correct for nonstandard conditions.
d. Determining the statistical variation of the results in terms of the average value and standard deviation of the particular quantities, the correlation among two or more quantities, etc.
e. Conversion of test data measurement units to compatible units given in test criteria or test item specifications.

It is noted that the test directive (or operation) itself serves to define the types and characteristics of the raw test data, and the ultimate objective of the test program defines the form of the test data desired.

Specific instruction for the reduction and presentation of individual sub-test data are outlined in subsequent paragraphs.

6.4.1 Preoperational Inspection

The extent of damage as well as any adjustments required should be reported. This report should also provide recommendations for improving the design, construction or packaging of the test item to resolve those problems reported.

6.4.2 Performance

6.4.2.1 Pneumograph Test - Air Leakage Rate

The pneumograph chart tracing which constitutes the air leakage rate test record shall be reduced to a graph of suitable dimensions for presentation. Graph axes shall be calibrated in units of elapsed time and pen displacement in units relative to the pneumo index line.

6.4.2.2 Pneumograph Test - Dynamic Range

Dynamic range raw test data shall be reduced to and presented as a family of curves showing pneumograph pen excursion (dependent variable) as a function of chest tube extension length (independent variable) with the sensitivity control setting as the family parameter.

6.4.2.3 Pneumograph Test - Frequency Response

Portions of the pneumograph chart tracing which constitute the frequency response test record shall be extracted from the chart for final presentation. Chart excerpts shall be selected to show the degradation/limitation effects encountered by the pneumograph system as the chest tube's sinusoidal displacement is increased in frequency. Chart excerpts shall display at least one complete cycle of the displacement curve and shall be suitably labeled as to pen displacement units, frequency and kymograph speed.

Chest tube displacement period as computed from motor speed (rpm) and as shown on the chart shall be analyzed with respect to test item kymograph speed to evaluate test item anomalous behavior and calibrate the kymograph chart speed.

6.4.2.4 Cardio-Sphygmograph Test - Air Leakage Rate

The cardio-sphygmograph air leakage raw test data shall be reduced and presented in a manner analogous to that specified in 6.2.2.4.

6.4.2.5 Cardio-Sphygmographic Test - Adequacy of Centering Control

The adequacy of centering control raw test data shall be reduced and presented in a manner analogous to that specified in 6.2.2.5.

6.4.2.6 Cardio-Sphygmographic Test - Sensitivity

Cardio-sphygmograph sensitivity test data shall be presented as a numerical ratio of pen deflection (in) per sphygmomanometer pressure increase (mm-Hg). One such ratio shall be presented for each test condition.

6.4.2.7 Galvanometer Test - Resistance Range

Maximum and minimum resistance values which can be balanced by the test item shall be presented together with a tabular listing of bridge circuit indicated resistance values versus decade resistance.

6.4.2.8 Galvanometer Test - Sensitivity

Galvanometer sensitivity raw test data shall be reduced to a suitable graphic presentation of pen deflection from galvanometer base line versus resistance over the range of interest.

6.4.2.9 Galvanometer Test - Self Center Function Response Time

The chart tracings which constitute the self-centering function response time shall be reduced to a graph of suitable dimensions for presentation. Graph axes shall be calibrated in units of elapsed time and pen displacement in units relative to the galvanometer base line. Each graph shall be identified with respect to decade resistance value and will indicate the time required by the test item to re-establish the base line trace.

6.4.2.10 Audio Section Tests

Audio section test data shall be reduced and presented in accordance with the applicable portion of the commodity engineering test procedure under which the test data was recorded.

GLOSSARY

Cardio-sphygmograph: An instrument that records graphically the movements or character of the human pulse.

Galvanograph: An electromechanical device that records graphically the change in a subjects skin resistance.

Pneumograph: A device for recording the volume change during respiration.

Sphygmomanometer: A gage used to indicate the inflation pressure of the cardio cuff.